PATENT ABSTRACTS OF JAPAN

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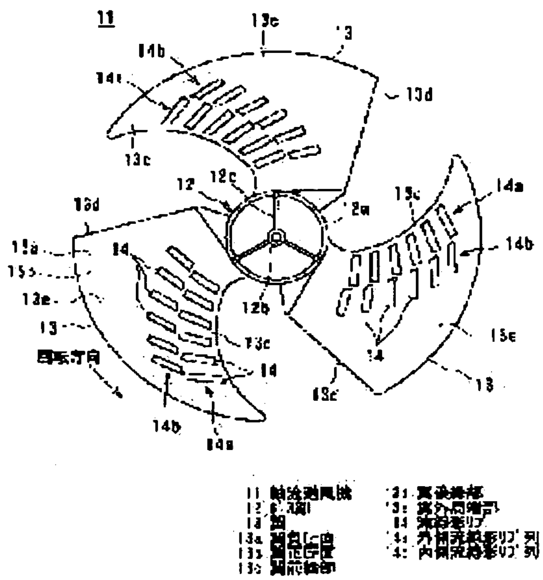
(71)Applicant : TOSHIBA KYARIA KK
(72)Inventor : ISHIJIMA MITSUYOSHI
SHIMIZU TOMOSHI

(54) AXIAL BLOWER

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an axial blower capable of lowering blowing noises while reducing the peeling of the flow to be generated in a blade negative pressure surface and improved in molding property thereof at a low cost.
SOLUTION: Plural blades 13 are arranged in the periphery of a boss part 12, to which a rotary shaft is fixed. Plural streamlined ribs 14 smoothly continued from a front edge thereof toward a blade rear edge part 13d are arranged in each blade 13 at a negative pressure surface 13a side front edge part 13c along the outline of the front edge with the predetermined space in the radial direction of a blower. These streamlined ribs 14 are arranged in plural lines 14a, 14b with the predetermined space in the circumferential direction of the blower.



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CLAIMS

[Claim(s)]
[Claim 1] the plurality of the streamline-shape rib which stands in a row smoothly towards a trailing edge in the axial blower which arranged two or more aerofoils in the periphery of the boss section to which a revolving shaft is fixed from that first transition in the suction-surface side first transition section of each above-mentioned aerofoil -- spacing predetermined to the blower radial -- placing -- the border line of the above-mentioned first transition -- meeting -- the shape of a train -- arranging -- this streamline-shape rib train -- spacing predetermined to a blower hoop direction -- placing -- two or more successive-installation beam -- the axial blower characterized by things.
[Claim 2] Each streamline-shape rib of the inside streamline-shape rib train prepared in the blower hoop direction inside rather than the outside streamline-shape rib train by the side of the leading edge is an axial blower according to claim 1 characterized by making include-angle thetaa of the ventilation side face which it shows to the ventilation direction of the inflow air incline in 12 degrees - 18 degrees to include-angle thetab of the ventilation side face of the above-mentioned outside streamline-shape rib train.
[Claim 3] Each streamline-shape rib of an inside streamline-shape rib train is an axial blower according to claim 1 or 2 characterized by enlarging as it is made to incline at each predetermined include angle to the segment OQ which connects the intersection Q of the revolving-shaft core O , an aerofoil periphery , and a trailing edge , respectively and goes each of these tilt angles to the streamline-shape rib by the side of the boss section from an aerofoil periphery .
[Claim 4] An inside streamline-shape rib train is an axial blower given in any 1 term of claims 1-3 characterized by forming the die length L2 along the blower hoop direction of each of these streamline-shape ribs in the die length of about 0.8L1 to the die length L1 along the blower hoop direction of each streamline-shape rib of an outside streamline-shape rib train while arranging each of that streamline-shape rib at equal intervals to the blower radial.
[Claim 5] An inside streamline-shape rib train is an axial blower given in any 1 term of claims 1-4 characterized by arranging the streamline-shape rib in the location corresponding to the gap of the streamline-shape ribs of an outside streamline-shape rib train.
[Claim 6] When the core of the radii curve which connects blower hoop direction each first transition of each streamline-shape rib of an outside streamline-shape rib train for blower hoop direction each of that first transition is set to P and the radius is set to r1, each streamline-shape rib of an inside streamline-shape rib train An axial blower given in any 1 term of claims 1-5 which are the Core P and this alignment, and are characterized by making it located on the radii line of the larger radius r2 than a radius r1.
[Claim 7] Each streamline-shape rib of the streamline-shape rib train of inside and outside both sides is an axial blower given in any 1 term of claims 1-6 characterized by forming mostly all the width of face in alignment with the blower radial in the same width of face.
[Claim 8] Each streamline-shape rib of an inside streamline-shape rib train is an axial blower

given in any 1 term of claims 1-7 characterized by being formed in one so that the outside surface of the cross section along the blower hoop direction may become [the direction of the radius Ra of some radii curved surfaces] larger than the radius Rb of the radii curved surface of the section besides the opposite hand the leading edge side of nothing and its radii outside surface about a circular face .
[Claim 9] Each streamline-shape rib of an inside streamline-shape rib train the cross-section height which meets in the direction of blade thickness While making it **** so that it may become high gradually as it goes reverse to an aerofoil periphery side from a boss section side with the thickness of the leading edge section cross section which becomes thin gradually as it goes in the direction of an aerofoil periphery from a boss section side An axial blower given in any 1 term of claims 1-8 characterized by being set up so that it may be set to h1=2h2 when the height of the streamline-shape rib nearest to the above-mentioned aerofoil periphery is set to h1 and the height of the streamline-shape rib nearest to the above-mentioned boss section is set to h2.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the suitable axial blower for an outdoor fan, a ventilator, etc. of an air conditioner, and relates to the axial blower which controlled the flow separation on an aerofoil suction surface, and aimed at both improvement in the air blasting engine performance, and reduction of an air blasting sound especially.
[0002]
[Description of the Prior Art] the front view when seeing drawing 13 from the aerofoil suction-surface side of the conventional axial blower 1 and drawing 14 illustrated one aerofoil of the axial blower 1, and omitted other aerofoils -- it is a notching front view a part. Two or more aerofoils 3 and 3 -- are put on the periphery side face of the cylinder-like boss section 2 in which the revolving shaft which is not illustrated is fixed to Core O, and this axial blower 1 forms the pitch predetermined to a hoop direction in it for them really or in one. Each aerofoil 3 has 3d of suction surfaces by the side of the fluid intake indicated to be concave arc-like first transition section 3a which makes the upstream edge of airstream to the blower hand of cut (hoop direction) shown by the drawing Nakaya mark, trailing-edge section 3b which makes the downstream edge of airstream, and periphery edge 3c of a convex arc also by drawing 15 , and pressure-surface 3e by the side of the rear face.
[0003] And while forming the thickness of first transition section 3a by the side of 3d of suction surfaces of each aerofoil 3 in 3f of heavy-gage parts of a streamline shape thicker than the trailing-edge section, on [of 3f of this streamline-shape heavy-gage part] first transition section 3a, mostly, a transverse-plane configuration keeps predetermined spacing in the blower radial along with the border line (visible outline) of first transition section 3a, and is arranging two

or more rectangular streamline-shape ribs 4 in the shape of a train.
[0004] Drawing 15 shows the airfoil profile of the hoop direction in the part into which arbitration distance r Separated from the axial center O of the revolving shaft which is fixed to the core of the boss section 2 as drawing 12 shows, and which is not illustrated radially.
[0005] Since 3f of streamline-shape heavy-gage parts is formed in first transition section 3a by the side of 3d of suction surfaces of each aerofoil 3 as shown in this drawing 15 , and two or more streamline-shape ribs 4 are moreover arranged on 3f of that streamline-shape heavy-gage part, after air flow U which flowed from this 3d side first transition section 3of aerofoil suction surfaces a ventilates the streamline-shape rib 4, it becomes the longitudinal vortex train Uz. For this reason, since it can control that air flow exfoliates from 3d of suction surfaces, the width of face of the trailing vortex fu generated behind trailing-edge section 3b (lower stream of a river) can be reduced, and an air blasting sound can be reduced.
[0006]
[Problem(s) to be Solved by the Invention] However, in such a conventional axial blower 1, since the streamline-shape rib 4 is arranged only for one train, the technical problem that the air blasting sound reduction effectiveness is not necessarily enough occurs.
[0007] This invention was made in consideration of such a situation, it is cheap and the object is in the thing which can reduce further exfoliation of the flow generated in an aerofoil suction surface, and can reduce an air blasting sound further and for which an axial blower with a good moldability is offered.
[0008]
[Means for Solving the Problem] In the axial blower with which invention concerning claim 1 arranged two or more aerofoils in the periphery of the boss section to which a revolving shaft is fixed The plurality of the streamline-shape rib which stands in a row smoothly towards a trailing edge from the first transition in the suction-surface side first transition section of each above-mentioned aerofoil spacing predetermined to the blower radial -- placing -- the border line of the above-mentioned first transition -- meeting -- the shape of a train -- arranging -- this streamline-shape rib train -- spacing predetermined to a blower hoop direction -- placing -- two or more successive installation beam -- it is the axial blower characterized by things.
[0009] Each streamline-shape rib of the inside streamline-shape rib train which prepared invention concerning claim 2 in the blower hoop direction inside rather than the outside streamline-shape rib train by the side of the leading edge is an axial blower according to claim 1 characterized by to make include-angle thetaa of the ventilation side face which it shows to the ventilation direction of the inflow air incline in 12 degrees - 18 degrees to include-angle thetab of the ventilation side face of the above-mentioned outside streamline-shape rib train.
[0010] Invention concerning claim 3 be an axial blower according to claim 1 or 2 characterize by enlarge each streamline shape rib of an inside streamline shape rib train as it be make to incline at each predetermined include angle to the segment OQ which connect the intersection Q of the revolving shaft core O , an aerofoil periphery , and a trailing edge , respectively and go each of these tilt angles to the streamline shape rib by the side of the boss section from an aerofoil periphery .
[0011] Invention concerning claim 4 an inside streamline-shape rib train While arranging each of that streamline-shape rib at equal intervals to the blower radial, the die length L2 along the blower hoop direction of each of these streamline-shape ribs It is an axial blower given in any 1 term of claims 1-3 characterized by forming in the die length of about 0.8L1 to the die length L1 along the blower hoop direction of each streamline-shape rib of an outside streamline-shape rib train.
[0012] Invention concerning claim 5 is an axial blower given in any 1 term of claims 1-4 characterized by the inside streamline-shape rib train arranging the streamline-shape rib in the location corresponding to the gap of the streamline-shape ribs of an outside streamline-shape rib train.
[0013] Invention concerning claim 6 each streamline-shape rib of an inside streamline-shape rib train When the core of the radii curve which connects blower hoop direction each first transition of each streamline-shape rib of an outside streamline-shape rib train for blower hoop direction

each of that first transition is set to P and the radius is set to r1 It is an axial blower given in any 1 term of claims 1-5 which are the Core P and this alignment, and are characterized by making it located on the radii line of the larger radius r2 than a radius r1.
[0014] Invention concerning claim 7 is an axial blower given in any 1 term of claims 1-6 to which all width of face to which each streamline-shape rib of the streamline-shape rib train of outside both sides meets the blower radial is characterized by being mostly formed in the same width of face inside.
[0015] Invention concerning claim 8 is an axial blower given in any 1 term of claims 1-7 characterize by form each streamline shape rib of an inside streamline shape rib train in one so that the outside surface of the cross section along the blower hoop direction may become [the direction of the radius Ra of some radii curved surfaces] larger than the radius Rb of the radii curved surface of the section besides the opposite hand the leading edge side of nothing and its radii outside surface about a circular face .
[0016] Invention concerning claim 9 each streamline-shape rib of an inside streamline-shape rib train While making the cross-section height which meets in the direction of blade thickness **** so that it may become high gradually as it goes reverse to an aerofoil periphery side from a boss section side with the thickness of the leading edge section cross section which becomes thin gradually as it goes in the direction of an aerofoil periphery from a boss section side When the height of the streamline-shape rib nearest to the above-mentioned aerofoil periphery is set to h1 and the height of the streamline-shape rib nearest to the above-mentioned boss section is set to h2, it is an axial blower given in any 1 term of claims 1-8 characterized by being set up so that it may be set to h1=2h2.
[0017] If each aerofoil rotates to the circumference of the axial center of the boss section by revolution of an axial blower, since according to these invention of each the air flow which flowed into the first transition section by the side of the suction surface of each aerofoil from the method of the outside will pass the streamline-shape rib of two or more trains, respectively and will serve as a longitudinal vortex train, a turbulent sublayer changes from a laminar boundary layer on an aerofoil suction surface. Since this turbulent sublayer narrows width of face of the trailing vortex which it is hard to generate the flow separation of an air current rather than a laminar boundary layer, and results an air blasting sound, an air blasting sound can be reduced. And the above-mentioned streamline-shape rib can make width of face of the trailing vortex which results an air blasting sound still narrower than the conventional example in which only a streamline-shape rib of only one train shown by above-mentioned drawing 13 etc. is by that of double sequence-of-numbers **** in the ventilation direction. For this reason, an air blasting sound can be reduced further. Furthermore, since each streamline-shape rib can really be easily fabricated for example, by resin mould molding etc. on each aerofoils, a moldability is good and can reduce a manufacturing cost.
[0018] Moreover, since it can be stabilized and a longitudinal vortex train can be generated on an aerofoil suction surface among these invention according to invention of claims 4-8, the reduction effectiveness of an air blasting sound can be increased further.
[0019] Furthermore, since a meat surface sink can be prevented and also a cooldown delay can be shortened in case this axial blower is really fabricated with resin mould shaping, since the cross-section thickness of the first transition section including the height of each streamline-shape rib and the thickness of the leading edge section becomes almost equal also in which a blower radial part according to invention of claim 9, shaping cost can be reduced.
[0020]
[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained based on drawing 1 - drawing 12 . In addition, the same sign is given to the same or a considerable part among these drawings.
[0021] when [whole] drawing 1 looks at the axial blower 11 concerning 1 operation gestalt of this invention from an aerofoil suction-surface side, the front view and drawing 2 which show a configuration illustrate the one aerofoil, carry out a graphic display abbreviation and show other aerofoils -- it is a notching front view a part. As shown in these drawings, the axial blower 11 has attached two or more aerofoils 13, 13, and 13 in the periphery side face of the cylinder-like

boss section 12 really thru/or in one for example, in the hoop direction division-into-equal-parts location, for example, is fabricated by one with resin mould shaping etc.
[0022] the boss section 12 is prolonged in a radial from small-circle tubed boss 12b for making the revolving shaft of the drive motor which is not illustrated insert in the internal core of closed-end cylinder-like body 12a, and fixing to it, and this boss 12b, and is connected with the inner skin of boss body 12a at one -- the manifold type of the reverse [of Y characters]-like connection rib 12c is mostly carried out to one.
[0023] Pressure-surface 13b each aerofoil 13 of whose is a suction-surface 13a and air blasting [of a rear face] side by the side of air drawing on the other hand, Concave arc-like first transition section 13c which makes the upstream edge of the airstream of each aerofoil 13 to drawing 1 R> 1 and the blower hand of cut shown by the drawing 2 Nakaya mark, Periphery edge 13e of a convex arc which comes to connect with one the 13d of trailing-edge sections which make the downstream edge of airstream, and sections [these first transition section 13c and 13d of trailing-edge sections] direction outer edges of a path is formed in one.
[0024] And in two or more streamline-shape ribs 14 with which a transverse-plane configuration stands [on first transition section 13c by the side of suction-surface 13a / mostly] in a row smoothly towards the direction of 13d of trailing-edge sections from the first transition (front end) of first transition section 13c in a rectangle, each aerofoil 13 puts regular intervals on the blower radial, and meets the border line (visible outline) of each first transition section 13c. Outside streamline-shape rib train 14a is formed by arranging in the shape of a train. Furthermore, rather than this outside streamline-shape rib train 14a, in predetermined spacing detached building ******, predetermined regular intervals were put on the blower radial for two or more streamline-shape ribs 14 to 13d side (that is, aerofoil inner surface side) of blower hoop direction trailing-edge sections, it arranged in the shape of a train, inside streamline-shape rib train 14b was formed, and the outside streamline-shape rib trains 14b and 14a are formed in juxtaposition in these.
[0025] And as shown in drawing 2 , each streamline-shape rib 14 of inside streamline-shape rib train 14b is making the ventilation side face 14b1 which it shows to the ventilation direction of the air flow incline at an include angle theta to the ventilation side face 14a1 of each streamline-shape rib 14 of outside streamline-shape rib train 14a near [the] the outside, and is set as the range of 12 degrees - 18 degrees as the include angle theta.
[0026] Moreover, they are each predetermined include angles alpha1, alpha2, and alpha3 also to the segment OQ with which the ventilation side face 14b1 of each streamline-shape rib 14 of inside streamline-shape rib train 14b connects the intersection Q of the blower center of rotation O, i.e., the core of the boss section 12, the trailing edge of 13d of trailing-edge sections, and aerofoil periphery 13e as shown in drawing 3 . -- It inclines by alphan. And whenever [these tilt-angles], whenever [tilt-angle] becomes large gradually as it goes to include-angle alphan of the ventilation side face 14b1 of the streamline-shape rib 14 nearest to the boss section 12 from the include angle alpha 1 of the ventilation side face 14b1 of the streamline-shape rib 14 nearest to aerofoil periphery 13e, and alpha 1 - alphan are set as alphan=2alpha1.
[0027] Drawing 4 shows the condition of air flow U by the side of aerofoil suction-surface 13a of the axial blower 11 constituted in this way by the arrow. Drawing 5 shows the condition of air flow U which flows the airfoil profile and airfoil profile when cutting from the core of the boss section 2 to a blower hoop direction in the arbitration part of an aerofoil 13 which separated predetermined distance r1 radially as drawing 4 shows. An arrow shows the flow direction of air among these drawings, and the revolution of an arrow expresses the longitudinal vortex train Uz.
[0028] Air flow U which flowed on aerofoil suction-surface 13a from the first transition fillet of the first transition section 13c passes outside streamline-shape rib train 14a and inside streamline-shape rib train 14b, respectively, becomes the longitudinal vortex train Uz, and makes an aerofoil suction-surface 13a top change from a laminar boundary layer to a turbulent sublayer in the above-mentioned axial blower 11, as shown in these drawing 4 and drawing 5 . Width of face of the trailing vortex fz which results an air blasting sound can be narrowed by this, and an air blasting sound can be reduced.
[0029] And according to this axial blower 11, the rib train of the streamline-shape rib 14 can

make a duplex generate the longitudinal vortex train Uz on aerofoil suction-surface 13a inside, outside 2 train 14b and when [since it 14a is, among these] air flow U passes the outside streamline-shape rib trains 14b and 14a. For this reason, since the yield of the longitudinal vortex train Uz can be increased rather than the axial blower 1 of the former shown, for example by drawing 13 in which only the streamline-shape rib 14 of only one train is, width of face of the trailing vortex fz which caused the air blasting sound can be made still narrower, and that part and blast weight can be reduced further. In addition, the three or more trains above-mentioned streamline-shape rib 14b may be prepared.
[0030] And as shown in drawing 6 , the die length L2 of the longitudinal direction along the blower hoop direction of each of that streamline-shape rib 14 is formed briefer than the die length L1 of the longitudinal direction along the blower hoop direction of each streamline-shape rib 14 of outside streamline-shape rib train 14a, for example, the above-mentioned inside streamline-shape rib train 14b forms it in 0.8L1. Moreover, the spacing W of the direction of a path of each streamline-shape rib 14 of inside streamline-shape rib train 14b is set up mostly at equal intervals.
[0031] Furthermore, as shown in drawing 7 , each streamline-shape rib 14 of inside streamline-shape rib train 14b is arranged in the location corresponding to the gap of streamline-shape rib 14 comrades which adjoin each other by the blower radial of outside streamline-shape rib train 14a.
[0032] As shown in drawing 8 , when the core of radii curvilinear 15a of the imagination which connects the first transition (drawing 8 right end) of each streamline-shape rib 14 of outside streamline-shape rib train 14a is set to P further again and the radius is set to ra It is the Core P and this alignment, and it arranges so that the first transition of each streamline-shape rib 14 of inside streamline-shape rib train 14b may be located on radii curvilinear 15b of imagination of the radius rb of a major diameter rather than a radius ra.
[0033] Moreover, as shown in drawing 9 , the blower radial width of face Wa of each streamline-shape rib 14 in outside streamline-shape rib train 14a and the blower radial width of face Wb of each streamline-shape rib 14 in inside streamline-shape rib train 14b are mostly formed in the same width of face.
[0034] Drawing 10 shows circular cross-section 14c when cutting each streamline-shape rib 14 of inside streamline-shape rib train 14b along a blower hoop direction, and when the radius of curvature of the section 14c2 is set to rd the second half which is rc and the other sections about the radius of curvâture of the first portion 14c1 which is a part by the side of that leading edge section 13c, this circular cross-section 14c is formed so that rc>rd may be materialized.
[0035] By the way, the thickness h0 of the airfoil profile which meets the blower radial of first transition section 13c of each aerofoil 13 as shown in drawing 11 is ****(ed) so that it may become thin gradually, as it goes to the aerofoil periphery 13e side Zb from the boss section 12 side Za.
[0036] On the other hand, as shown in drawing 12 , the gradual change of it is carried out so that it may become high gradually, as the height of each streamline-shape rib 14 goes to the aerofoil periphery 13e side Yb from the boss section 12 side Ya, and it is formed so that the height h1 of the streamline-shape rib nearest to aerofoil periphery 13e and the height h2 of the streamline-shape rib 14 nearest to the boss section 12 may be set to h1=2h2. That is, since the direction which the height of each streamline-shape rib 14 increases, and goes, and the direction which increases the thickness of aerofoil suction-surface side first transition section 13c, and goes are the opposite, the cross-section thickness ht including the thickness h0 of this first transition section 13c becomes almost equal in any part. For this reason, compaction, a meat surface sink, etc. of the cooldown delay of shaping can really by the time of resin shaping of an axial blower 11 be prevented thru/or reduced.
[0037] Moreover, since the axial blower 11 set up the curvature of the die length L2 of the longitudinal direction of each streamline-shape rib 14 of inside streamline-shape rib train 14b, the installation spacing W, an installation location, the location of first transition, width of face Wb, and a radii outside surface etc. as mentioned above, respectively, it can stabilize and generate a longitudinal vortex train on aerofoil suction-surface 13a, therefore can reduce an air

blasting sound further.
[0038]
[Effect of the Invention] As explained above, this invention can make small trailing-vortex width of face which the suction-surface side first transition section of each aerofoil is made to generate the longitudinal vortex train of air flow on an aerofoil suction surface, and can control exfoliation of flow in it, as a result is made in it in trailing-edge section back since two or more trains side-by-side installation of the streamline-shape rib which stands in a row smoothly from the first transition edge is carried out, and can reduce an air blasting sound. Moreover, since each streamline-shape rib is a streamline shape-like, an axial blower can really be easily fabricated for example, with resin mould shaping, and both improvement and manufacturing-cost reduction of a moldability can be aimed at.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The front view of the whole configuration when seeing the axial blower concerning 1 operation gestalt of this invention from an aerofoil suction-surface side.
[Drawing 2] It is a notching front view a part for explaining whenever [tilt-angle / of the ventilation side face of each streamline-shape rib in the inside streamline-shape rib train of the axial blower shown by drawing 1].
[Drawing 3] It is a notching front view in the case of changing the tilt angle of each streamline-shape rib in the inside streamline-shape rib train of the axial blower shown by drawing 1 , respectively a part.
[Drawing 4] the part which shows the condition of the aerofoil suction-surface absentminded mind flow of the axial blower shown by drawing 1 etc. -- a notching front view.
[Drawing 5] The aerofoil sectional view when cutting the aerofoil of the axial blower shown by drawing 4 along a blower hoop direction in a radius r1.
[Drawing 6] the part which shows the longitudinal direction die length of each streamline-shape rib and arrangement spacing of each ribs in the inside streamline-shape rib train of the axial blower shown by drawing 1 etc. -- a notching front view.
[Drawing 7] It is a notching front view in the case of arranging each streamline-shape rib of the inside streamline-shape rib train in the axial blower shown by drawing 1 etc. in the location corresponding to the gap of each streamline-shape ribs of an outside streamline-shape rib train a part.
[Drawing 8] the part which shows the physical relationship of the first transition of each streamline-shape rib of the outside streamline-shape rib train in the axial blower shown by drawing 1 etc., and the first transition of each streamline-shape rib of an inside streamline-shape rib train, respectively -- a notching front view.
[Drawing 9] It is a notching front view a part for explaining the width of face of each streamline-shape rib of the inside in the axial blower shown by drawing 1 etc., and an outside streamline-

shape rib train.
[Drawing 10] Drawing of longitudinal section of each streamline-shape rib shown by drawing 1 etc.
[Drawing 11] The sectional view in alignment with the blower radial of the first transition section of the axial blower shown by drawing 1 etc.
[Drawing 12] The mimetic diagram showing the cross section when cutting the boss section and the inside streamline-shape rib train which are shown by drawing 1 etc. in accordance with the blower radial.
[Drawing 13] The front view when seeing from the suction-surface side of the conventional axial blower.
[Drawing 14] the part which shows one aerofoil of the conventional axial blower shown by drawing 13 -- a notching front view.
[Drawing 15] The aerofoil sectional view when cutting an aerofoil to a hoop direction with a radius of arbitration from the bottom of its heart during a revolution of the axial blower shown by drawing 13 .
[Description of Notations]
11 Axial Blower
12 Boss Section
13 Aerofoil
13a The suction surface of an aerofoil
13c The first transition section of an aerofoil
13d The trailing-edge section of an aerofoil
13e The periphery edge of an aerofoil
14 Streamline-Shape Rib
14a Outside streamline-shape rib train
14b Inside streamline-shape rib train
15a, 15b Outside, inside radii curve

[Translation done.]

DRAWINGS

[Drawing 1]

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(71)出願人　399023877
東芝キャリア株式会社
東京都港区芝浦１丁目１番１号

(72)発明者　石嶋　満義
静岡県富士市蓼原336番地　東芝キャリア株式会社内

(72)発明者　清水　知史
静岡県富士市蓼原336番地　東芝キャリア株式会社内

(74)代理人　100078765
弁理士　波多野　久　（外１名）

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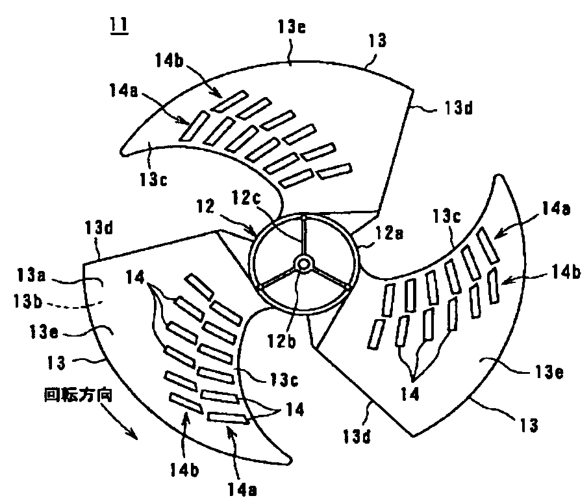
EE08

(54)【発明の名称】　軸流送風機

(57)【要約】

【課題】翼負圧面で発生する流れの剥離をさらに低減して送風音をさらに低減することができる安価で成形性の良好な軸流送風機を提供する。

【解決手段】回転軸が固定されるボス部１２の外周に、複数の翼１３を配設する。各翼の負圧面１３ａ側前縁部１３ｃに、その前縁から翼後縁部１３ｄに向けて滑かに連なる流線形リブ１４の複数を、送風機半径方向に所定の間隔を置いて前縁の輪郭線に沿って列状に配設し、この流線形リブ列を送風機周方向に所定の間隔を置いて複数列１４ａ，１４ｂ設ける。



11 軸流送風機
12 ボス部
13 翼
13a 翼負圧面
13b 翼正圧面
13c 翼前縁部
13d 翼後縁部
13e 翼外周端部
14 流線形リブ
14a 外側流線形リブ列
14b 内側流線形リブ列

【特許請求の範囲】

【請求項１】　回転軸が固定されるボス部の外周に、複数の翼を配設した軸流送風機において、

上記各翼の負圧面側前縁部に、その前縁から翼後縁に向けて滑かに連なる流線形リブの複数を、送風機半径方向に所定の間隔を置いて上記前縁の輪郭線に沿って列状に配設し、この流線形リブ列を送風機周方向に所定の間隔を置いて複数列設けたことを特徴とする軸流送風機。

【請求項２】　翼前縁側の外側流線形リブ列よりも送風機周方向内側に設けた内側流線形リブ列の各流線形リブは、その流入空気の通風方向を案内する通風側面の角度θａを、上記外側流線形リブ列の通風側面の角度θｂに対して１２°～１８°の範囲で傾斜させていることを特徴とする請求項１記載の軸流送風機。

【請求項３】　内側流線形リブ列の各流線形リブは、回転軸中心Ｏと、翼外周と翼後縁との交点Ｑと、を結ぶ線分ＯＱに対して各々の所定角度でそれぞれ傾斜させ、これらの各傾斜角を翼外周からボス部側の流線形リブに行くに従って大きくすることを特徴とする請求項１または２記載の軸流送風機。

【請求項４】　内側流線形リブ列は、その各流線形リブを送風機半径方向に等間隔で配置する一方、これらの各流線形リブの送風機周方向に沿う長さL_2を、外側流線形リブ列の各流線形リブの送風機周方向に沿う長さL_1に対し、ほぼ０．８L_1の長さに形成していることを特徴とする請求項１～３のいずれか１項に記載の軸流送風機。

【請求項５】　内側流線形リブ列は、その流線形リブを、外側流線形リブ列の流線形リブ同士の間隙に対応する位置に配設していることを特徴とする請求項１～４のいずれか１項に記載の軸流送風機。

【請求項６】　内側流線形リブ列の各流線形リブは、その送風機周方向各前縁を、外側流線形リブ列の各流線形リブの送風機周方向各前縁を結ぶ円弧曲線の中心をＰ、その半径をr_1としたときに、その中心Ｐと同心でかつ半径r_1よりも大きい半径r_2の円弧線上に位置させていることを特徴とする請求項１～５のいずれか１項に記載の軸流送風機。

【請求項７】　内，外両側の流線形リブ列の各流線形リブは、その送風機半径方向に沿う幅がみなほぼ同一幅に形成されていることを特徴とする請求項１～６のいずれか１項に記載の軸流送風機。

【請求項８】　内側流線形リブ列の各流線形リブは、その送風機周方向に沿う断面の外面が円弧面をなし、その円弧外面の翼前縁側一部の円弧曲面の半径Ｒａの方が、その反対側他部の円弧曲面の半径Ｒｂよりも大きくなるように一体に形成されていることを特徴とする請求項１～７のいずれか１項に記載の軸流送風機。

【請求項９】　内側流線形リブ列の各流線形リブは、その翼厚方向に沿う断面高さを、ボス部側から翼外周方向に行くに従って漸次薄くなる翼前縁部断面の厚さとは逆にボス部側から翼外周側に行くに従って漸次高くなるように除変させると共に、上記翼外周に最も近い流線形リブの高さをh_1とし、上記ボス部に最も近い流線形リブの高さをh_2としたときに、$h_1 = 2h_2$となるように設定されていることを特徴とする請求項１～８のいずれか１項に記載の軸流送風機。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、例えば空気調和機の室外ファンや換気装置等に好適な軸流送風機に係り、特に、翼負圧面上の流れの剥離を抑制して送風性能の向上と送風音の低減とを共に図った軸流送風機に関する。

【０００２】

【従来の技術】図１３は従来の軸流送風機１の翼負圧面側から見たときの正面図、図１４は、その軸流送風機１の翼１枚分を図示して他の翼を省略した一部切欠正面図である。この軸流送風機１は、図示しない回転軸が中心部Ｏに固定される円筒状のボス部２の外周側面に、複数の翼３，３…を周方向に所定のピッチを置いて一体または一体的に形成している。各翼３は、図中矢印で示す送風機回転方向（周方向）に対して空気流の上流側端部をなす凹弧状の前縁部３ａと、空気流の下流側端部をなす後縁部３ｂと、凸弧状の外周端部３ｃと、図１５でも示す流体吸込側の負圧面３ｄと、その裏面側の正圧面３ｅとを有する。

【０００３】そして、各翼３の負圧面３ｄ側の前縁部３ａの厚さを後縁部よりも厚い流線形の厚肉部３ｆに形成すると共に、この流線形厚肉部３ｆの前縁部３ａ上に、正面形状がほぼ矩形の複数の流線形リブ４を前縁部３ａの輪郭線（外形線）に沿って送風機半径方向に所定間隔を置いて列状に配設している。

【０００４】図１５は図１２で示すようにボス部２の中心部に固定される図示しない回転軸の軸心Ｏから半径方向に任意の距離ｒ離れた部分における周方向の翼断面を示している。

【０００５】この図１５に示すように各翼３の負圧面３ｄ側の前縁部３ａには、流線形厚肉部３ｆが形成され、しかもその流線形厚肉部３ｆ上には複数の流線形リブ４を配設しているので、この翼負圧面３ｄ側前縁部３ａから流入した空気流れＵが流線形リブ４を通風した後に縦渦列Ｕｚになる。このために、負圧面３ｄから空気流れが剥離するのを抑制することができるので、後縁部３ｂの後方（下流）に発生する後流渦ｆｕの幅を縮小して送風音を低減させることができる。

【０００６】

【発明が解決しようとする課題】しかしながら、このような従来の軸流送風機１では、流線形リブ４が１列しか配列されていないので、送風音低減効果が必ずしも十分ではないという課題がある。

【０００７】本発明はこのような事情を考慮してなされたもので、その目的は、翼負圧面で発生する流れの剥離をさらに低減して送風音をさらに低減することができる安価で成形性の良好な軸流送風機を提供することにある。

【０００８】

【課題を解決するための手段】請求項１に係る発明は、回転軸が固定されるボス部の外周に、複数の翼を配設した軸流送風機において、上記各翼の負圧面側前縁部に、その前縁から翼後縁に向けて滑かに連なる流線形リブの複数を、送風機半径方向に所定の間隔を置いて上記前縁の輪郭線に沿って列状に配設し、この流線形リブ列を送風機周方向に所定の間隔を置いて複数列設けたことを特徴とする軸流送風機である。

【０００９】請求項２に係る発明は、翼前縁側の外側流線形リブ列よりも送風機周方向内側に設けた内側流線形リブ列の各流線形リブは、その流入空気の通風方向を案内する通風側面の角度θａを、上記外側流線形リブ列の通風側面の角度θｂに対して１２°～１８°の範囲で傾斜させていることを特徴とする請求項１記載の軸流送風機である。

【００１０】請求項３に係る発明は、内側流線形リブ列の各流線形リブは、回転軸中心Ｏと、翼外周と翼後縁との交点Ｑと、を結ぶ線分ＯＱに対して各々の所定角度でそれぞれ傾斜させ、これらの各傾斜角を翼外周からボス部側の流線形リブに行くに従って大きくすることを特徴とする請求項１または２記載の軸流送風機である。

【００１１】請求項４に係る発明は、内側流線形リブ列は、その各流線形リブを送風機半径方向に等間隔で配置する一方、これらの各流線形リブの送風機周方向に沿う長さL_2を、外側流線形リブ列の各流線形リブの送風機周方向に沿う長さL_1に対し、ほぼ０．８L_1の長さに形成していることを特徴とする請求項１～３のいずれか１項に記載の軸流送風機である。

【００１２】請求項５に係る発明は、内側流線形リブ列は、その流線形リブを、外側流線形リブ列の流線形リブ同士の間隙に対応する位置に配設していることを特徴とする請求項１～４のいずれか１項に記載の軸流送風機である。

【００１３】請求項６に係る発明は、内側流線形リブ列の各流線形リブは、その送風機周方向各前縁を、外側流線形リブ列の各流線形リブの送風機周方向各前縁を結ぶ円弧曲線の中心をＰ、その半径をr_1としたときに、その中心Ｐと同心でかつ半径r_1よりも大きい半径r_2の円弧線上に位置させていることを特徴とする請求項１～５のいずれか１項に記載の軸流送風機である。

【００１４】請求項７に係る発明は、内，外両側の流線形リブ列の各流線形リブは、その送風機半径方向に沿う幅がみなほぼ同一幅に形成されていることを特徴とする請求項１～６のいずれか１項に記載の軸流送風機である。

【００１５】請求項８に係る発明は、内側流線形リブ列の各流線形リブは、その送風機周方向に沿う断面の外面が円弧面をなし、その円弧外面の翼前縁側一部の円弧曲面の半径Ｒａの方が、その反対側他部の円弧曲面の半径Ｒｂよりも大きくなるように一体に形成されていることを特徴とする請求項１～７のいずれか１項に記載の軸流送風機である。

【００１６】請求項９に係る発明は、内側流線形リブ列の各流線形リブは、その翼厚方向に沿う断面高さを、ボス部側から翼外周方向に行くに従って漸次薄くなる翼前縁部断面の厚さとは逆にボス部側から翼外周側に行くに従って漸次高くなるように除変させると共に、上記翼外周に最も近い流線形リブの高さをh_1とし、上記ボス部に最も近い流線形リブの高さをh_2としたときに、$h_1=2h_2$となるように設定されていることを特徴とする請求項１～８のいずれか１項に記載の軸流送風機である。

【００１７】これらの各発明によれば、軸流送風機の回転により各翼がボス部の軸心周りに回転すると、各翼の負圧面側の前縁部に、その外方から流入した空気流れが複数列の流線形リブをそれぞれ通過して縦渦列となるので、翼負圧面上で層流境界層から乱流境界層に遷移される。この乱流境界層は層流境界層よりも気流の流れの剥離が発生しにくいうえに、送風音の原因をなす後流渦の幅を狭くするので、送風音を低減することができる。しかも、上記流線形リブが通風方向に複数列あるので、上記図１３等で示す流線形リブが１列しかない従来例よりも、送風音の原因をなす後流渦の幅をさらに狭くすることができる。このために、送風音をさらに低減することができる。さらに、各流線形リブは各翼に例えば樹脂モールド成型等により簡単に一体成形できるので、成形性が良好であり、製造コストを低減できる。

【００１８】また、これらの発明のうち、請求項４～８の発明によれば、翼負圧面上で縦渦列を安定して発生させることができるので、送風音の低減効果をさらに増大させることができる。

【００１９】さらに、請求項９の発明によれば、各流線形リブの高さと、翼前縁部の厚さを含めた前縁部の断面厚さが送風機半径方向のいずれの箇所においてもほぼ等しくなるので、この軸流送風機を樹脂モールド成形により一体成形する際には、肉ひけを防止することができるうえに、冷却時間を短縮することができるので、成形コストを低減することができる。

【００２０】

【発明の実施の形態】以下、本発明の実施形態を図１～図１２に基づいて説明する。なお、これらの図中、同一または相当部分には同一符号を付している。

【００２１】図１は本発明の一実施形態に係る軸流送風機１１を翼負圧面側から見たときの全体構成を示す正面

図、図２はその翼１枚分を図示して他の翼を図示省略して示す一部切欠正面図である。これらの図に示すように軸流送風機１１は円筒状のボス部１２の外周側面に、複数の翼１３，１３，１３を例えば周方向等分位置にて一体ないし一体的に取り付けており、例えば樹脂モールド成形等により一体に成形される。

【００２２】ボス部１２は有底円筒状の本体１２ａの内部中心部に、図示しない駆動モータの回転軸を挿入させて固定するための小円筒状のボス１２ｂと、このボス１２ｂから放射状に延びてボス本体１２ａの内周面に一体に連結するほぼ逆Ｙ字状の連結リブ１２ｃとを一体に連成している。

【００２３】一方、各翼１３は、空気吸込側の負圧面１３ａと、その裏面の送風側である正圧面１３ｂと、図１，図２中矢印で示す送風機回転方向に対し、各翼１３の空気流の上流側端部をなす凹弧状の前縁部１３ｃと、空気流の下流側端部をなす後縁部１３ｄと、これら前縁部１３ｃと後縁部１３ｄの径方向外端同士を一体に連結してなる凸弧状の外周端部１３ｅとを一体に形成している。

【００２４】そして、各翼１３は、負圧面１３ａ側の前縁部１３ｃ上に、正面形状がほぼ長方形で前縁部１３ｃの前縁（前端）から後縁部１３ｄ方向に向けて滑かに連なる複数の流線形リブ１４を送風機半径方向に等間隔を置いて各前縁部１３ｃの輪郭線（外形線）に沿って、列状に配置することにより外側流線形リブ列１４ａを形成している。さらに、この外側流線形リブ列１４ａよりも送風機周方向後縁部１３ｄ側（つまり翼内面側）へ所定間隔離れた箇所において、複数の流線形リブ１４を送風機半径方向に所定の等間隔を置いて列状に配設して内側流線形リブ列１４ｂを形成し、これら内，外側流線形リブ列１４ｂ，１４ａを並列に設けている。

【００２５】そして、図２に示すように内側流線形リブ列１４ｂの各流線形リブ１４は、その空気流れの通風方向を案内する通風側面$14b_1$を、その外側近傍の外側流線形リブ列１４ａの各流線形リブ１４の通風側面$14a_1$に対して角度θで傾斜させており、その角度θとしては例えば１２°～１８°の範囲に設定されている。

【００２６】また、図３に示すように内側流線形リブ列１４ｂの各流線形リブ１４の通風側面$14b_1$は、送風機回転中心、すなわちボス部１２の中心Ｏと、翼後縁部１３ｄの後縁と翼外周１３ｅとの交点Ｑと、を結ぶ線分ＯＱに対しても、各所定角度α_1，α_2，α_3…α_nで傾斜している。しかも、これら傾斜角度α_1～α_nは、翼外周１３ｅに最も近い流線形リブ１４の通風側面$14b_1$の角度α_1からボス部１２に最も近い流線形リブ１４の通風側面$14b_1$の角度αｎに行くに従って漸次傾斜角度が大きくなり、$\alpha_n=2\alpha_1$に設定されている。

【００２７】図４はこのように構成された軸流送風機１１の翼負圧面１３ａ側の空気流れＵの状態を矢印線で示している。図５は図４で示すようにボス部２の中心から半径方向に所定距離r_1離れた翼１３の任意箇所において送風機周方向に切断したときの翼断面と、その翼断面を流れる空気流れＵの状態を示している。これらの図中、矢印線は空気の流れ方向を示し、矢印線の回転は縦渦列Ｕｚを表している。

【００２８】これら図４，図５に示すように、上記軸流送風機１１では、その前縁部１３ｃの前縁フィレットから翼負圧面１３ａ上に流入した空気流れＵが外側流線形リブ列１４ａと内側流線形リブ列１４ｂとをそれぞれ通過して、縦渦列Ｕｚとなり、翼負圧面１３ａ上を層流境界層から乱流境界層に遷移させる。これにより、送風音の原因をなす後流渦ｆｚの幅を狭くして送風音を低減させることができる。

【００２９】しかも、この軸流送風機１１によれば、流線形リブ１４のリブ列が内，外２列１４ｂ，１４ａあるので、この内，外流線形リブ列１４ｂ，１４ａを空気流れＵが通過することにより翼負圧面１３ａ上で２重に縦渦列Ｕｚを発生させることができる。このために、流線形リブ１４が１列しかない例えば図１３で示す従来の軸流送風機１よりも縦渦列Ｕｚの発生量を増大させることができるので、送風音の原因である後流渦ｆｚの幅をさらに狭くすることとができ、その分、送風量をさらに低減することができる。なお、上記流線形リブ１４ｂは３列以上設けてもよい。

【００３０】そして、図６に示すように上記内側流線形リブ列１４ｂは、その各流線形リブ１４の送風機周方向に沿う長手方向の長さL_2を、外側流線形リブ列１４ａの各流線形リブ１４の送風機周方向に沿う長手方向の長さL_1よりも短かく形成し、例えば$0.8L_1$に形成している。また、内側流線形リブ列１４ｂの各流線形リブ１４の径方向の間隔Ｗをほぼ等間隔に設定している。

【００３１】さらに、図７に示すように内側流線形リブ列１４ｂの各流線形リブ１４を、外側流線形リブ列１４ａの送風機半径方向で隣り合う流線形リブ１４同士の間隙に対応する位置に配設している。

【００３２】さらにまた、図８に示すように、外側流線形リブ列１４ａの各流線形リブ１４の前縁（図８では右端）同士を結ぶ仮想の円弧曲線１５ａの中心をＰ、その半径をｒａとしたときに、その中心Ｐと同心でかつ半径ｒａよりも大径の半径ｒｂの仮想の円弧曲線１５ｂ上に、内側流線形リブ列１４ｂの各流線形リブ１４の前縁が位置するように配置している。

【００３３】また、図９に示すように外側流線形リブ列１４ａにおける各流線形リブ１４の送風機半径方向の幅Ｗａと、内側流線形リブ列１４ｂにおける各流線形リブ１４の送風機半径方向の幅Ｗｂとをほぼ同一幅に形成している。

【００３４】図１０は内側流線形リブ列１４ｂの各流線形リブ１４を送風機周方向に沿って切断したときの円弧

状断面１４ｃを示しており、この円弧状断面１４ｃは、その翼前縁部１３ｃ側の一部である前半部１４ｃ１の曲率半径をｒｃ、その他部である後半部１４ｃ２の曲率半径をｒｄとしたときにｒｃ＞ｒｄが成立するように形成されている。

【００３５】ところで、図１１に示すように各翼１３の前縁部１３ｃの送風機半径方向に沿う翼断面の厚さh_0はボス部１２側Ｚａから翼外周１３ｅ側Ｚｂへ行くに従って漸次薄くなるように除変されている。

【００３６】一方、図１２に示すように各流線形リブ１４の高さは、ボス部１２側Ｙａから翼外周１３ｅ側Ｙｂへ行くに従って漸次高くなるように徐変されており、翼外周１３ｅに最も近い流線形リブの高さh_1と、ボス部１２に最も近い流線形リブ１４の高さh_2とは、$h_1 = 2h_2$となるように形成されている。すなわち、各流線形リブ１４の高さが増して行く方向と、翼負圧面側前縁部１３ｃの厚さを増して行く方向とが正反対であるので、この前縁部１３ｃの厚さh_0を含めた断面厚さh_tがいずれの箇所でもほぼ等しくなる。このため、軸流送風機１１の樹脂成形時による一体成形の冷却時間の短縮および肉ひけ等を防止ないし低減することができる。

【００３７】また、軸流送風機１１は以上のように内側流線形リブ列１４ｂの各流線形リブ１４の長手方向の長さL_2、設置間隔Ｗ、設置位置、前縁の位置、幅Ｗｂ、円弧外面の曲率等をそれぞれ設定したので、縦渦列を翼負圧面１３ａ上に安定して発生させることができ、そのために送風音をさらに低減することができる。

【００３８】

【発明の効果】以上説明したように、本発明は各翼の負圧面側前縁部に、その前縁端から滑らかに連なる流線形リブを複数列並設しているので、翼負圧面上にて空気流れの縦渦列を発生させ、流れの剥離を抑制することができ、ひいては翼後縁部後方にできる後流渦幅を小さくして送風音を低減することができる。また、各流線形リブが流線形状であるので、軸流送風機を例えば樹脂モールド成形により簡単に一体成形でき、成形性の向上と製造コスト低減とを共に図ることができる。

【図面の簡単な説明】

【図１】本発明の一実施形態に係る軸流送風機を翼負圧面側から見たときの全体構成の正面図。

【図２】図１で示す軸流送風機の内側流線形リブ列における各流線形リブの通風側面の傾斜角度を説明するための一部切欠正面図。

【図３】図１で示す軸流送風機の内側流線形リブ列における各流線形リブの傾斜角をそれぞれ変える場合の一部切欠正面図。

【図４】図１等で示す軸流送風機の翼負圧面上の空気流れの状態を示す一部切欠正面図。

【図５】図４で示す軸流送風機の翼を半径r_1にて送風機周方向に沿って切断したときの翼断面図。

【図６】図１等で示す軸流送風機の内側流線形リブ列における各流線形リブの長手方向長さと各リブ同士の配置間隔を示す一部切欠正面図。

【図７】図１等で示す軸流送風機における内側流線形リブ列の各流線形リブを、外側流線形リブ列の各流線形リブ同士の間隙に対応する位置に配置する場合の一部切欠正面図。

【図８】図１等で示す軸流送風機における外側流線形リブ列の各流線形リブの前縁と、内側流線形リブ列の各流線形リブの前縁の位置関係をそれぞれ示す一部切欠正面図。

【図９】図１等で示す軸流送風機における内，外側流線形リブ列の各流線形リブの幅を説明するための一部切欠正面図。

【図１０】図１等で示す各流線形リブの縦断面図。

【図１１】図１等で示す軸流送風機の前縁部の送風機半径方向に沿う断面図。

【図１２】図１等で示すボス部と内側流線形リブ列とを送風機半径方向に沿って切断したときの断面を示す模式図。

【図１３】従来の軸流送風機の負圧面側から見たときの正面図。

【図１４】図１３で示す従来の軸流送風機の翼１枚分を示す一部切欠正面図。

【図１５】図１３で示す軸流送風機の回転中心から任意の半径で翼を周方向に切断したときの翼断面図。

【符号の説明】

１１　軸流送風機
１２　ボス部
１３　翼
１３ａ　翼の負圧面
１３ｃ　翼の前縁部
１３ｄ　翼の後縁部
１３ｅ　翼の外周端部
１４　流線形リブ
１４ａ　外側流線形リブ列
１４ｂ　内側流線形リブ列
１５ａ，１５ｂ　外，内側円弧曲線